

WHAT IS CLAIMED IS:

1. A resin transfer molding process, steps of which comprise:
  - (a) providing a heat curable composition into a closed mold containing a preform;
  - (b) exposing the interior of the mold to a first elevated temperature and elevated pressure sufficient to wet the preform with the heat curable composition; and
  - (c) curing the heat curable composition-impregnated preform within the mold at a second elevated temperature to form a resin transfer molded product, wherein the heat curable composition comprises (i) a benzoxazine component.
2. The resin transfer molding process of Claim 1, wherein the heat curable composition further comprises (ii) a toughener component comprising acrylonitrile-butadiene copolymer having secondary amine terminal groups.
3. The resin transfer molding process of Claim 1, wherein the heat curable composition further comprises:
  - (ii) an epoxy or episulfide component;
  - (iii) optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;
  - (iv) optionally, an acrylonitrile-butadiene copolymer, a polyimide component, and a polyimide/siloxane component; and
  - (v) optionally, a curative.
4. The resin transfer molding process of Claim 1, wherein the heat curable composition has a viscosity in the

range of 10 to 3000 centipoise at the resin injection temperature.

5. The resin transfer molding process of Claim 1, wherein the time within which the viscosity of the heat curable composition increases by 100% under the process conditions is in the range of 1 to 10 hours at the injection temperature.

6. The resin transfer molding process of Claim 1 wherein the plurality of fabric plies or unidirectional plies comprises fibers selected from glass, carbon, aramid and ceramics.

7. A resin transfer molded product made by the process of Claims 1-6.

8. A resin transfer molding preform comprising:

(a) a plurality of fabric plies or unidirectional plies and

(b) a heat curable binder composition, tacked to the plurality of fabric plies or unidirectional plies, wherein the heat curable binder composition comprises (i) a benzoxazine component.

9. The resin transfer molding preform of Claim 8, wherein the heat curable binder composition further comprises (ii) a toughener component comprising acrylonitrile-butadiene co-polymer having secondary amine terminal groups.

10. The resin transfer molding preform of Claim 8, wherein the heat curable binder composition further comprises:

- (ii) an epoxy or episulfide component;
- (iii) optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;
- (iv) optionally, an acrylonitrile-butadiene copolymer, a polyimide component, and a polyimide/siloxane component; and
- (v) optionally, a curative.

11. The resin transfer molding preform of Claim 8, wherein the heat curable binder composition further comprises optionally, a spacer selected from the group consisting of particles constructed of thermoplastics, rubbers, metals, carbon, core shell, ceramics and combinations thereof.

12. The resin transfer molding preform of Claim 8, wherein the plurality of fabric plies or unidirectional plies comprises fibers selected from glass, carbon, aramid and ceramics.

13. A binder composition comprising a solid benzoxazine component, which is partially cured by exposure to elevated temperature conditions over time sufficient to increase the melting point higher than the temperature at which a matrix resin composition is to be infused into a preform and lower than the point at which the partially cured binder composition and the matrix resin composition are miscible.

14. The binder composition of Claim 13, further comprising a spacer selected from the group consisting of

particles constructed of thermoplastics, rubbers, metals, carbon, core shell, ceramics and combinations thereof.

15. The binder composition of Claim 13, further comprising a toughener component comprising acrylonitrile-butadiene co-polymer having secondary amine terminal groups.

16. The binder composition of Claim 13, further comprising:

an epoxy or episulfide component;  
optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;

optionally, an acrylonitrile-butadiene co-polymer, a polyimide component, and a polyimide/siloxane component; and

optionally, a curative.

17. A vacuum assisted resin transfer molding process, steps of which comprise:

- (a) providing a preform into a mold;
- (b) providing a heat curable composition into the mold under a first elevated temperature and under vacuum for a time sufficient to allow the composition to wet the preform; and
- (c) exposing the mold containing the composition wetted-preform to a second elevated temperature while under vacuum sufficient to cure the heat curable composition-wetted preform within the mold to form a resin transfer molded product, wherein the heat curable composition comprises (i) a benzoxazine component.

18. The vacuum assisted resin transfer molding process of Claim 17, wherein after providing the preform a dispersing medium is provided thereover.

19. The vacuum assisted resin transfer molding process of Claim 17, wherein the heat curable composition further comprises (ii) a toughener component comprising acrylonitrile-butadiene co-polymer having secondary amine terminal groups.

20. The vacuum assisted resin transfer molding process of Claim 17, wherein the heat curable composition further comprises:

- (ii) an epoxy or episulfide component;
- (iii) optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;
- (iv) optionally, an acrylonitrile-butadiene co-polymer, a polyimide component, and a polyimide/siloxane component; and
- (v) optionally, a curative.

21. The vacuum assisted resin transfer molding process of Claim 17, wherein the heat curable composition has a viscosity in the range of 10 to 2000 centipoise at transfer molding temperature.

22. The vacuum assisted resin transfer molding process of Claim 17, wherein the time within which the viscosity of the heat curable composition increases by 100% under the process conditions is in the range of 1 to 10 hours at the resin transfer temperature.

23. The vacuum assisted resin transfer molding process of Claim 17, wherein the preform comprises fibers selected from glass, carbon, aramid and ceramics.

24. A vacuum assisted resin transfer molded product made by the process of Claims 17-23.

25. A vacuum assisted resin transfer molding preform comprising:

- (a) a plurality of fabric plies or unidirectional plies and
- (b) a heat curable binder composition, tacked to the plurality of fabric plies or unidirectional plies, wherein the heat curable binder composition comprises (i) a benzoxazine component.

26. The vacuum assisted resin transfer molding preform of Claim 25, wherein the heat curable binder composition further comprises (ii) a toughener component comprising acrylonitrile-butadiene co-polymer having secondary amine terminal groups.

27. The vacuum assisted resin transfer molding preform of Claim 25, wherein the heat curable binder composition further comprises:

- (ii) an epoxy or episulfide component;
- (iii) optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;
- (iv) optionally, an acrylonitrile-butadiene co-polymer, a polyimide component, and a polyimide/siloxane component; and

(v) optionally, a curative..

28. The vacuum assisted resin transfer molding preform of Claim 25, wherein the heat curable binder composition further comprises optionally, a spacer selected from the group consisting of particles constructed of thermoplastics, rubbers, metals, carbon, core shell, ceramics and combinations thereof.

29. The vacuum assisted resin transfer molding preform of Claim 25, wherein the plurality of fabric plies or unidirectional plies comprises fibers selected from glass, carbon, aramid and ceramics.

30. A binder composition comprising a solid benzoxazine component, which is partially cured by exposure to elevated temperature conditions over time sufficient to increase the melting point higher than the temperature at which a matrix resin composition is to be infused into a preform and lower than the point at which the partially cured binder composition and the matrix resin composition are miscible.

31. The binder composition of Claim 30, further comprising a spacer selected from the group consisting of particles constructed of thermoplastics, rubbers, metals, carbon, core shell, ceramics and combinations thereof.

32. The binder composition of Claim 30, further comprising a toughener component comprising acrylonitrile-butadiene co-polymer having secondary amine terminal groups.

33. A resin film infusion process, steps of which comprise:

(a) providing a preform into a closed mold containing a heat curable composition in film form;

(b) exposing the interior of the mold to a first elevated temperature and optionally vacuum, while the exterior of the mold is exposed to an elevated pressure, for a time sufficient to infuse the preform with the heat curable composition; and

(c) curing the heat curable composition-infused preform within the mold at a second elevated temperature to form a resin transfer molded product, wherein the heat curable composition comprises (i) a benzoxazine component.

34. The resin film infusion process of Claim 33, wherein the heat curable composition further comprises (ii) a toughener component comprising acrylonitrile-butadiene copolymer having secondary amine terminal groups.

35. The resin film infusion process of Claim 33, wherein the heat curable composition further comprises:

(ii) an epoxy or episulfide component;

(iii) optionally, one or more of an oxazoline component, a cyanate ester component, a phenolic component, and a thiophenolic component;

(iv) optionally, an acrylonitrile-butadiene copolymer, a polyimide component, and a polyimide/siloxane component; and

(v) optionally, a curative.

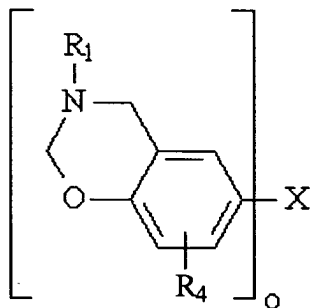
36. The resin film infusion process of Claim 33, wherein the heat curable composition has a viscosity in the range of 10 to 5000 centipoise at the infusion temperature.

37. The resin film infusion process of Claim 33, wherein the time within which the viscosity of the heat curable composition increases by 100% under the process conditions is in the range of 1 to 10 hours at the infusion temperature.

38. The resin film infusion process of Claim 33, wherein the preform comprises fibers selected from glass, carbon, aramid and ceramics.

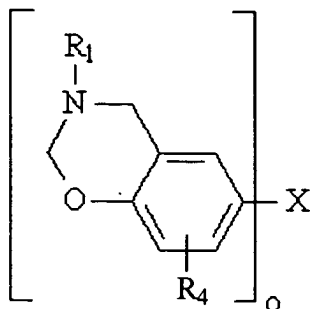
39. A resin film infused product made by the process of Claims 33-38.

40. The resin transfer molding process of Claim 1, wherein the benzoxazine of the heat curable composition comprises



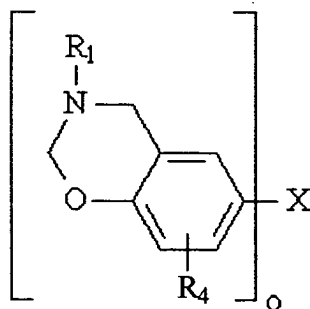
wherein  $o$  is 1-4,  $X$  is selected from the group consisting of a direct bond (when  $o$  is 2), alkyl (when  $o$  is 1), alkylene (when  $o$  is 2-4), carbonyl (when  $o$  is 2), thiol (when  $o$  is 1), thioether (when  $o$  is 2), sulfoxide (when  $o$  is 2), and sulfone (when  $o$  is 2),  $R_1$  is selected from the group consisting of hydrogen, alkyl and aryl, and  $R_4$  is selected from hydrogen, halogen and alkyl.

41. The vacuum assisted resin transfer molding process of Claim 15, wherein the benzoxazine of the heat curable composition comprises



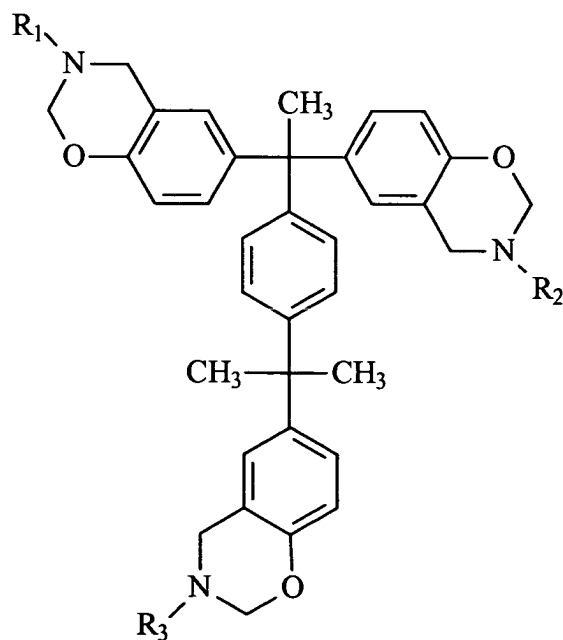
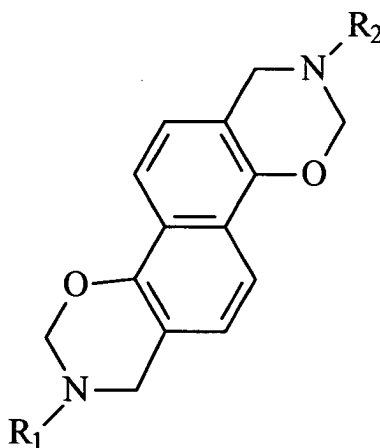
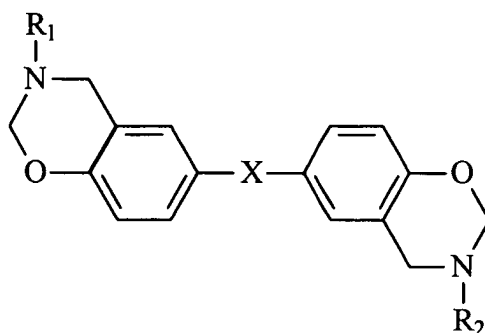
wherein  $o$  is 1-4,  $X$  is selected from the group consisting of a direct bond (when  $o$  is 2), alkyl (when  $o$  is 1), alkylene (when  $o$  is 2-4), carbonyl (when  $o$  is 2), thiol (when  $o$  is 1), thioether (when  $o$  is 2), sulfoxide (when  $o$  is 2), and sulfone (when  $o$  is 2),  $R_1$  is selected from the group consisting of hydrogen, alkyl and aryl, and  $R_4$  is selected from hydrogen, halogen and alkyl.

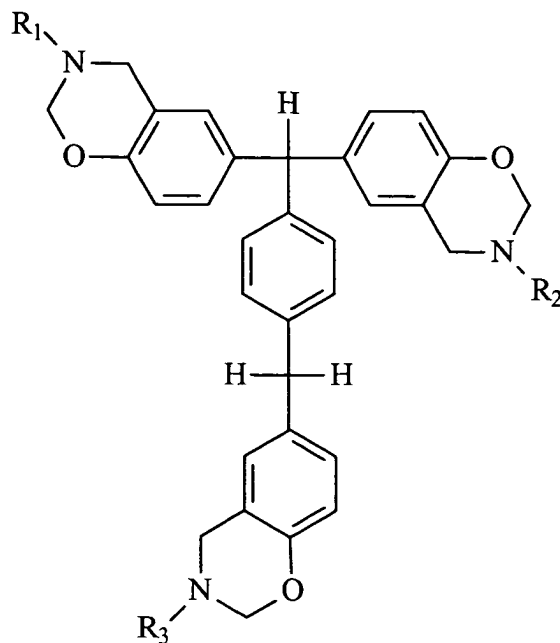
42. The resin film infusion process of Claim 25, wherein the benzoxazine component of the heat curable composition comprises



wherein  $o$  is 1-4,  $X$  is selected from the group consisting of a direct bond (when  $o$  is 2), alkyl (when  $o$  is 1), alkylene (when  $o$  is 2-4), carbonyl (when  $o$  is 2), thiol (when  $o$  is 1), thioether (when  $o$  is 2), sulfoxide (when  $o$  is 2), and sulfone (when  $o$  is 2),  $R_1$  is selected from the group consisting of hydrogen, alkyl and aryl, and  $R_4$  is selected from hydrogen, halogen and alkyl.

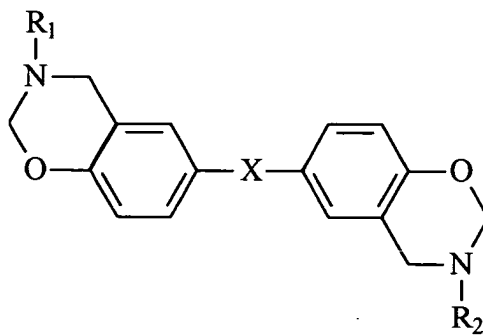
43. The resin transfer molding process of Claim 1, wherein the benzoxazine of the heat curable composition comprises one or more of

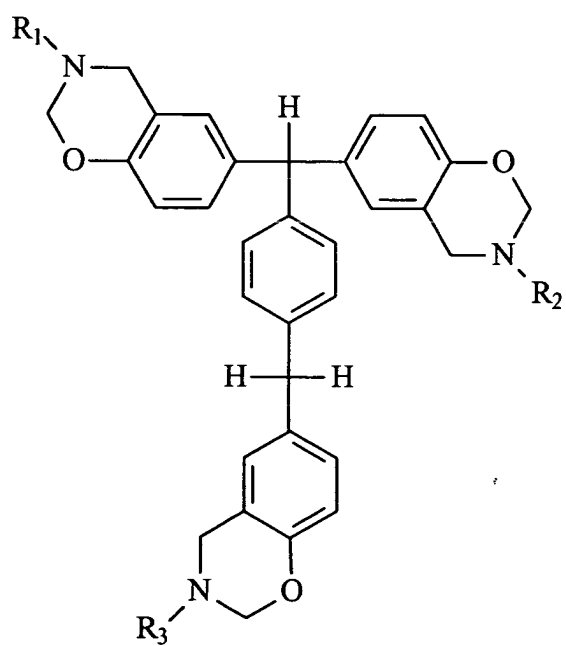
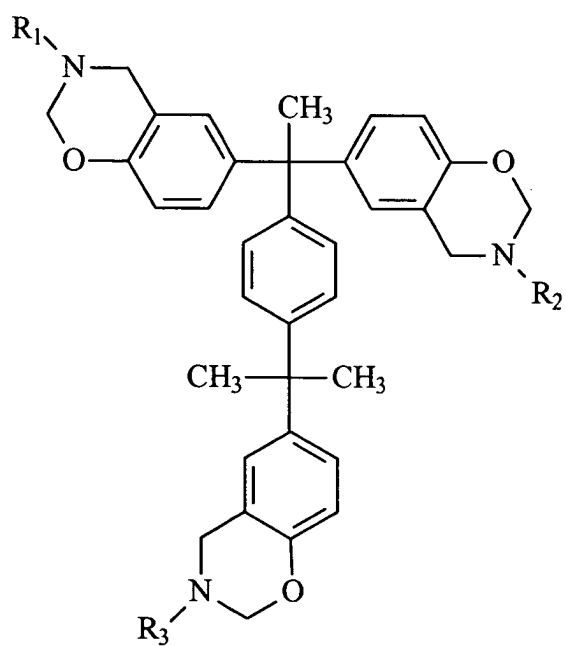
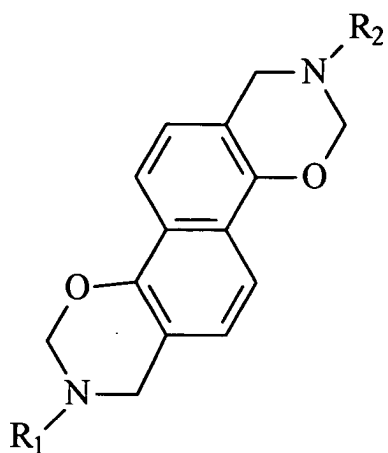




wherein X is selected from the group consisting of a direct bond,  $\text{CH}_2$ ,  $\text{C}(\text{CH}_3)_2$ ,  $\text{C}=\text{O}$ ,  $\text{S}$ ,  $\text{S}=\text{O}$  and  $\text{O}=\text{S}=\text{O}$ , and  $\text{R}_1$ ,  $\text{R}_2$  and  $\text{R}_3$  are the same or different and are selected from the group consisting of hydrogen, alkyl and aryl.

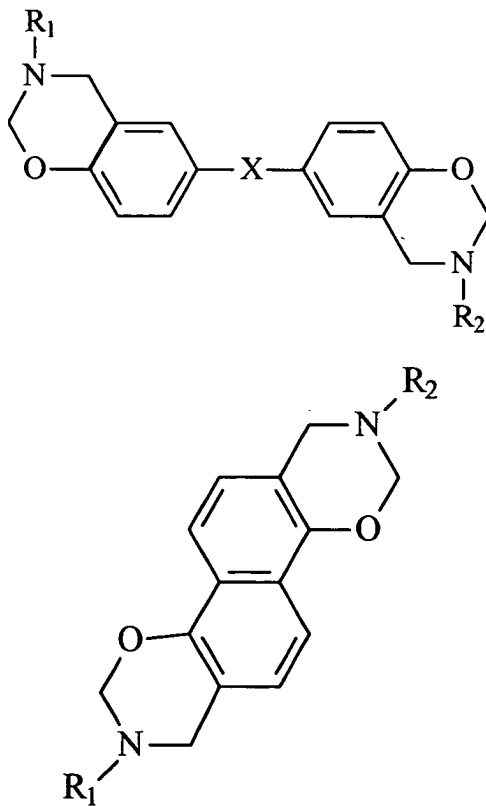
44. The vacuum assisted resin transfer molding process of Claim 15, wherein the benzoxazine component of the heat curable composition comprises one or more of

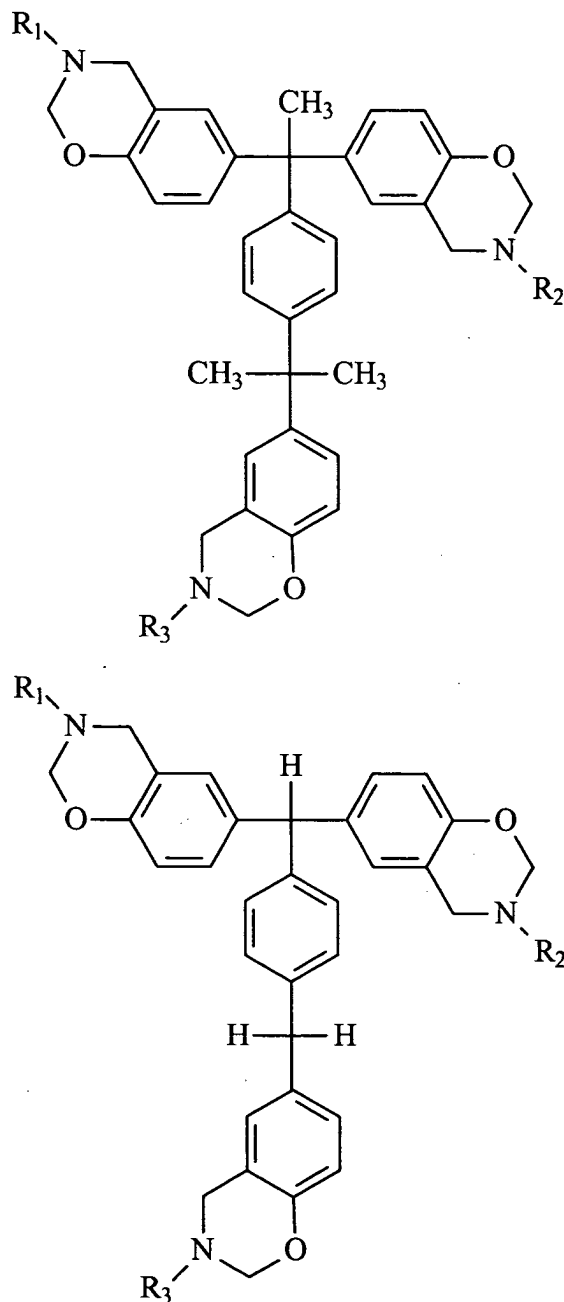




wherein X is selected from the group consisting of a direct bond,  $\text{CH}_2$ ,  $\text{C}(\text{CH}_3)_2$ ,  $\text{C}=\text{O}$ ,  $\text{S}$ ,  $\text{S}=\text{O}$  and  $\text{O}=\text{S}=\text{O}$ , and  $\text{R}_1$ ,  $\text{R}_2$  and  $\text{R}_3$  are the same or different and are selected from the group consisting of hydrogen, alkyl and aryl.

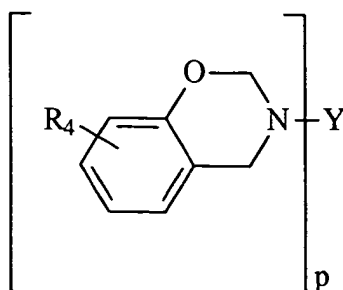
45. The resin film infusion process of Claim 25, wherein the benzoxazine component of the heat curable composition comprises one or more of





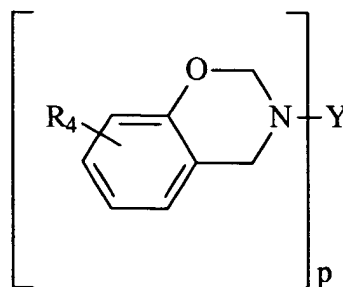
wherein X is selected from the group consisting of a direct bond, CH<sub>2</sub>, C(CH<sub>3</sub>)<sub>2</sub>, C=O, S, S=O and O=S=O, and R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> are the same or different and are selected from the group consisting of hydrogen, alkyl and aryl.

46. The resin transfer molding process of Claim 1, wherein the benzoxazine of the heat curable composition comprises



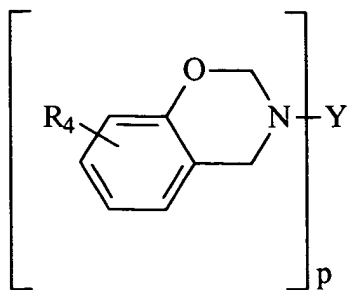
wherein p is 2, Y is selected from the group consisting of biphenyl (when p is 2), diphenyl methane (when p is 2), diphenyl isopropane (when p is 2), diphenyl sulfide (when p is 2), diphenyl sulfoxide (when p is 2), diphenyl sulfone (when p is 2), and diphenyl ketone (when p is 2), and R<sub>4</sub> is selected from hydrogen, halogen and alkyl.

47. The vacuum assisted resin transfer molding process of Claim 15, wherein the benzoxazine of the heat curable composition comprises



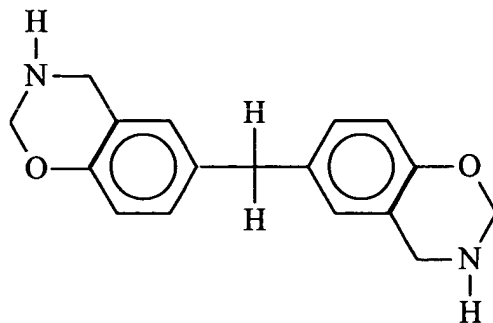
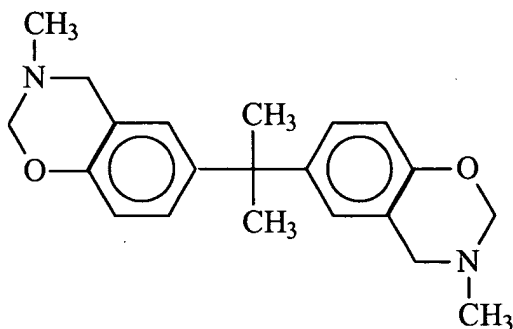
wherein p is 2, Y is selected from the group consisting of biphenyl (when p is 2), diphenyl methane (when p is 2), diphenyl isopropane (when p is 2), diphenyl sulfide (when p is 2), diphenyl sulfoxide (when p is 2), diphenyl sulfone (when p is 2), and diphenyl ketone (when p is 2), and R<sub>4</sub> is selected from hydrogen, halogen and alkyl.

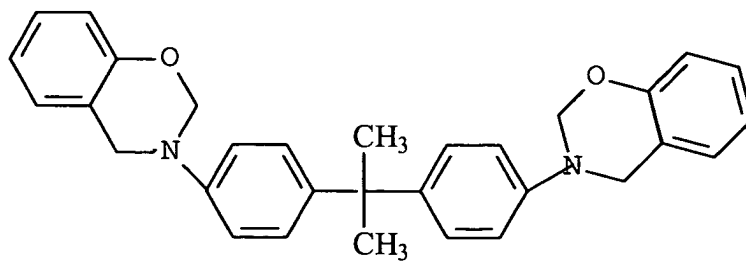
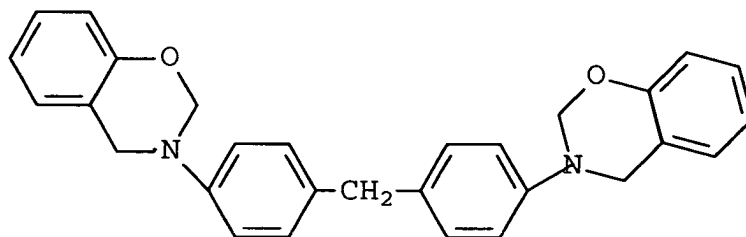
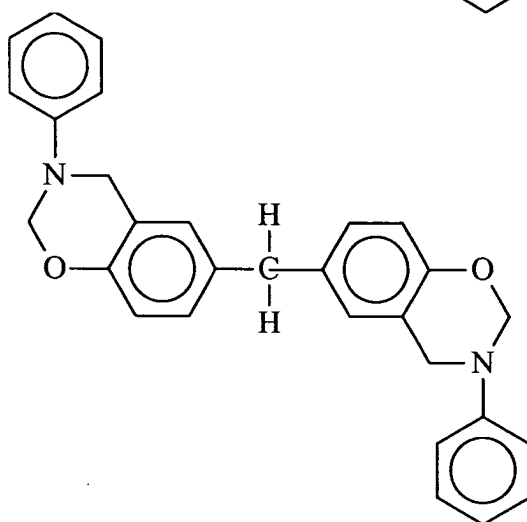
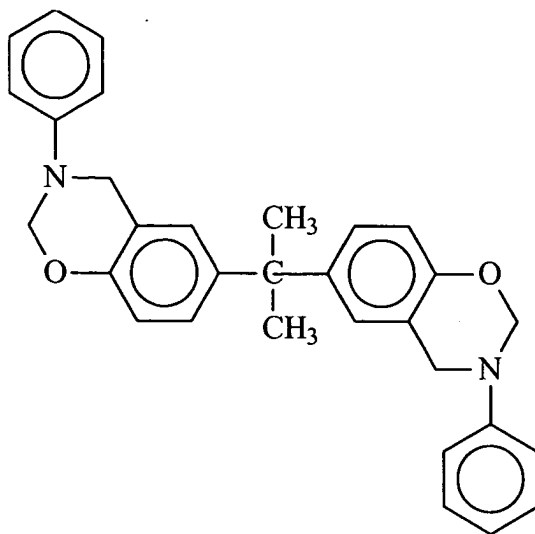
48. The resin film infusion process of Claim 25, wherein the benzoxazine component of the heat curable composition comprises



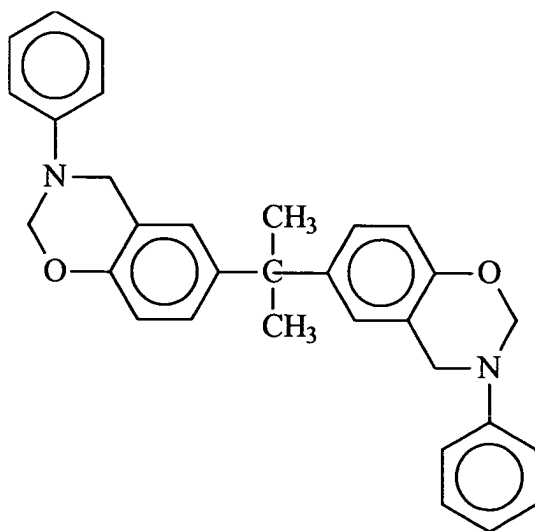
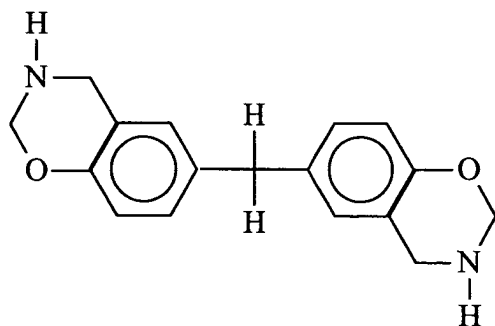
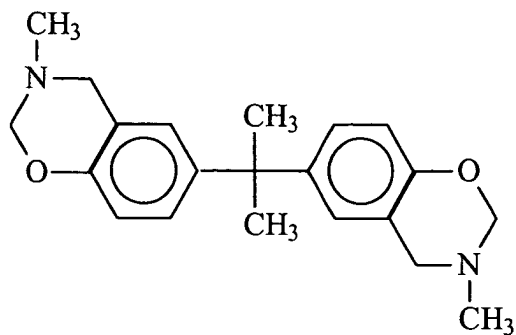
wherein p is 2, Y is selected from the group consisting of biphenyl (when p is 2), diphenyl methane (when p is 2), diphenyl isopropane (when p is 2), diphenyl sulfide (when p is 2), diphenyl sulfoxide (when p is 2), diphenyl sulfone (when p is 2), and diphenyl ketone (when p is 2), and R<sub>4</sub> is selected from hydrogen, halogen and alkyl.

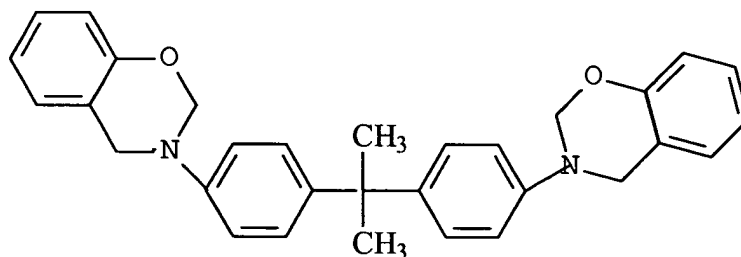
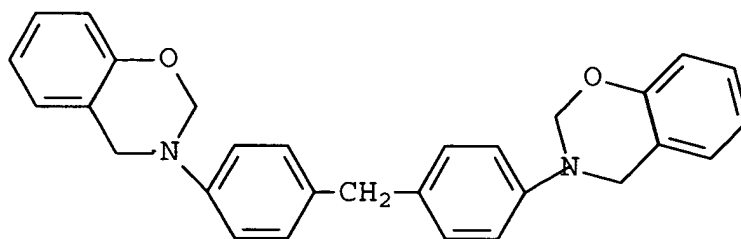
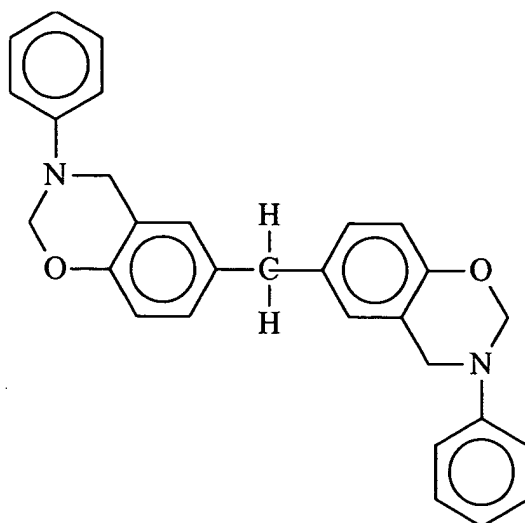
48. The resin transfer molding process of Claim 1, wherein the benzoxazine of the heat curable composition comprises one or more of





49. The vacuum assisted resin transfer molding process of Claim 15, wherein the benzoxazine component of the heat curable composition comprises one or more of





50. The resin film infusion process of Claim 25, wherein the benzoxazine component of the heat curable composition comprises one or more of

